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The Kingdom of Norway

Bekreftelse på patentsøknad nr
Certification of patent application no

2003 3583

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It is hereby certified that the annexed document is a true copy of the above-mentioned application, as originally filed on 2003.08.13

2003.08.22

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Kontaktinfo — Hvem skal Patentstyret henvende seg til? Oppgi telefonnummer og eventuell referanse.

Fornavn til kontaktperson for fullmektig *eller* søker: Olav

Etternavn: Holm

Telefon: 6 6 9 9 1 1 4 7

Referanse (maks. 30 tegn): Case 128090

Evt. adresse til kontaktperson:
Nexans Norway AS
Pb 130 Økern

Postnummer: 0509

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Fullmektig — Hvis du ikke har oppnevnt en fullmektig, kan du gå til neste punkt.

Foretakets navn (fornavn hvis fullmektig er person): Olav

Etternavn (hvis fullmektig er person): Holm

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Oppfinner — Oppfinneren skal alltid oppgis, selv om oppfinner og søker er samme person.

Oppfinnerens fornavn: Knut Ivar

Etternavn: Ekeberg

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SØKNAD s. 2 av 2

Tittel Gi en kort benevnelse eller tittel for oppfinnelsen (ikke over 256 tegn, inkludert mellomrom).

Tittel:

Vertical Cable Supporting Element

PCT Fylles bare ut hvis denne søknaden er en videreføring av en tidligere innlevert internasjonal søknad (PCT).

PCT-søknadens dato og nummer: Inngivelsesdato (åååå.mm.dd): Søknadsnummer: PCT /

Prioritetskrav Hvis du ikke har søkt om denne oppfinnelsen tidligere (i et annet land eller i Norge) kan du gå videre til neste punkt.

Prioritet kreves på grunnlag av tidligere innlevert søknad i Norge eller utlandet:

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Deponeringssted og nummer (benytt gjerne eget ark):

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☐ Utskilt søknad

Informasjon om opprinnelig søknad/innsendt tilleggsmateriale Dato (åååå.mm.dd): Søknadsnummer:

Annet

☐ Søknaden er også levert per telefaks. Oppgi dato (åååå.mm.dd):

☐ Jeg har bedt om forundersøkelse. Oppgi nr (årstall - nummer - bokstav):

Vedlegg Angi hvilken dokumentasjon av oppfinnelsen du legger ved, samt andre vedlegg.

☒ Eventuelle tegninger i to eksemplarer Oppgi antall tegninger: 4

☒ Beskrivelse av oppfinnelsen i to eksemplarer

☐ Patentkrav i to eksemplarer

☐ Sammendrag på norsk i to eksemplarer

☐ Dokumentasjon av eventuelle prioritetskrav (prioritetsbevis)

☐ Oversettelse av internasjonal søknad i to eksemplarer (kun hvis PCT-felt over er fylt ut)

☐ Fullmaktsdokument(er)

☐ Overdragelsesdokument(er)

☐ Erklæring om retten til oppfinnelsen

Dato/underskrift Sjekk at du har fylt ut punktene under «Søker», «Oppfinner» og «Vedlegg». Signer søknaden.

Sted og dato (blokkbokstaver):

Oslo, 12 august 2003

Navn i blokkbokstaver:

OLAV HOLM

Signatur:

NB! Søknadsavgiften vil bli fakturert for alle søknader (dvs. at søknadsavgiften ikke skal følge søknaden).
Betalingsfrist er ca. 1 måned, se faktura.

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INVENTION STUDY - FIT No 128090

Title: Vertical Cable Supporting Element

1) What is the technical problem which the author of this Invention Study had to solve?

The demand for electrical power supply at the sea floor increases with the increasing water depth at which oil production is being performed. This means that electrical power must be supplied through cables to the subsea system. These cables will need to hang freely suspended from the floating production vessel and down to the seabed.

Copper is the most common metal used in cables to transmit electrical power. Although having excellent properties for transmitting electrical power, copper does not have mechanical properties suitable for dynamic service in ultra deep water (up to more than 3000 m). Copper has a high density and a low mechanical strength. The high density leads to large inertia forces during dynamic service, and the low strength implies that copper will not contribute much to the cable's overall strength or axial stiffness. Furthermore, copper also has a relatively small acceptable max. strain limit as well as strain range to operate within in dynamic service compared to e.g. steel.

This invention study has therefore been conducted with the aim to find a device that ensures that the mass and inertia forces of a copper conductor are transferred to a strength member meter by meter all the way from the production vessel and down to the seabed. A thought model to illustrate the device can be a winding staircase; the power element can rest on each step in the staircase, and the mass of the element is transferred to the central load bearing element of the staircase. To accommodate "bending" of the staircase, the power element must be allowed to slide on the steps towards/away from the central load bearing element.

2) Which is to the knowledge of the author the best already existing (prior art) solution to this problem?

To the knowledge of the author, the best already existing solution to this problem is to use already existing cable technology, i.e. the power elements wound around each other in a bundle, and a number of load bearing armor layers are wound around this bundle. The load transferring mechanism (from the copper conductors to the load bearing armor layers) for such a construction is internal friction, which is an unreliable servant.

3) Why is this best prior art solution not good enough?

In traditional cable technology, the main load bearing components are the armor layers. And as already mentioned, the load transferring mechanism is internal friction – i.e. friction between the electrical elements and the armor layers. Another negative thing with the existing technology is that when the power elements are subjected to relatively high tensions, contact forces between the individual copper strands will also be relatively high. High contact forces and relative movement between copper strands may cause fretting to occur. Copper has relatively low fretting resistance.

The main reason for why traditional cable technology (with copper as the power/signal transmitting metal) is not good enough is that using internal friction as a design feature is highly unreliable, and that internal contact forces will be high (relatively speaking).

4) Basic idea of the author's solution.

The features necessary to succeed with copper in ultra deep water is to ensure low strains and low contact forces in the copper. This can be achieved by reducing the forces in the electrical element, which again can be achieved by increasing the reliability of the load-transferring feature from the electrical element to the load-bearing element.

One way to increase the reliability of the load transferring mechanism is to change the load bearing mechanism from being helically wound armor layers to being a central core element. This will increase the relative axial stiffness of the element, which thereby ensures lower element strains.

A thick plastic layer is extruded onto the central load-bearing element. The thickness of this layer is determined by the size f the electrical elements. The plastic layer as well as the plastic layer/load-bearing element interface must be capable of transferring the mass and inertia loads.

A second feature is to make helical grooves with a relatively large helical angle in this plastic layer and place the electrical elements in these grooves. The size of the helical angle will be determined by the balance between the amount of bending the complete element will be subjected to during installation/service and the practical amount of radial sliding the overall element design can accommodate. The helical angle reduces the amount friction must be relied upon to transfer the mass and inertia forces to the central element.

The last feature is that the grooves must be shaped in such a way that the electrical elements are allowed to slide towards/away from the central core in order to be able to accommodate bending of the element without increasing the mechanical loads in the copper.

A secondary feature of this element is when a steel tube is used as the central core. Such a cable element can for example provide power and lubrication to a subsea pump – i.e. it becomes a multifunction element.

Another secondary feature of this solution is that the principle can be used on more or less any size element, e.g. from a small signal elements used inside umbilicals to a large power cable.

5) Short description of the solution (add extra sheet and drawing(s) where necessary).

The basic idea of the present concept is to build up an element with a central load-bearing element. This element may be a steel tube, a steel rod, or any other type component with a suitable strength to weight ratio for the intended service. A thick plastic/elastic layer – such as crosslinked polyethylene (XLPE) or a thermoplastic polymer – is extruded onto the central load-bearing element. The thickness of the plastic layer must be

larger than the diameter of the electrical elements. A number of helical grooves (equivalent to the number of electrical elements) are made in the plastic layer. The helical angle of these grooves should be as large as practicably possible. The cross-sectional shape of the grooves should be such that the electrical element can slide radially or sideways in the groove (i.e. towards and from the central core), but be tight enough to transfer the mass and inertia forces.

6) Advantage(s) of the new solution (wherever possible with quantification) as compared with the best prior art solution(s) referred to under 2 above.
The new solution will make it possible to use copper as conductor material to much larger water depths compared to the best prior art solution.

Are there equivalent solutions with the same advantages?
There are no equivalent solutions to the author's knowledge.

If there are equivalent solutions, - why must this one be patented?
*

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7332 Løkken Verk
NORWAY

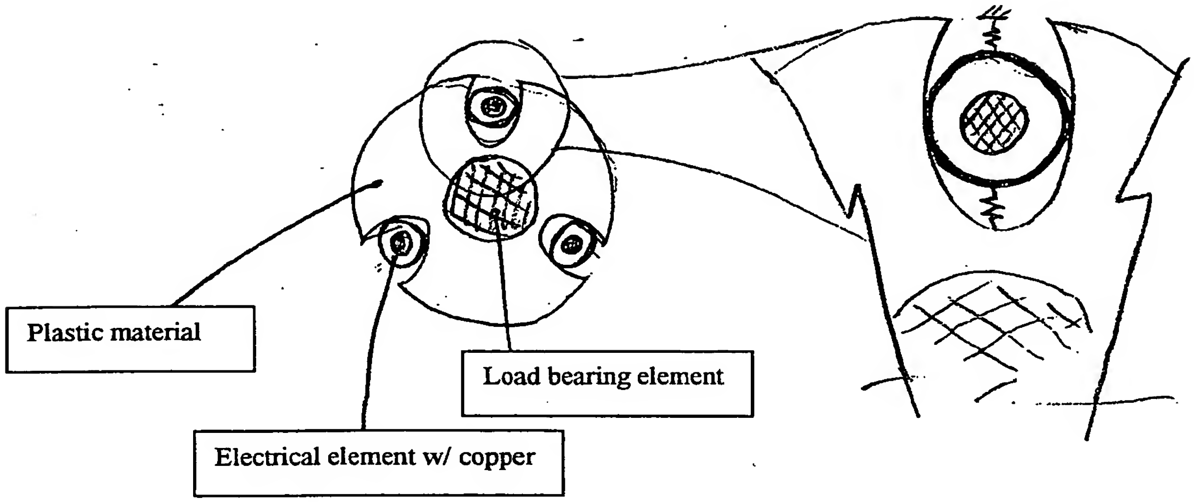
KIE/120603

Knut Ivar Ekeberg

19.05.2003

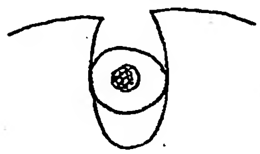
Attachment to point 5)

Mechanical Principle:

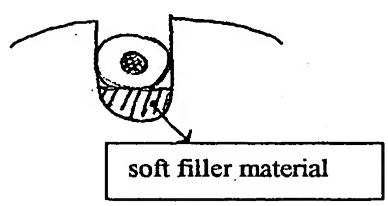


The desired radial movement may be achieved by applying one of the following principles:

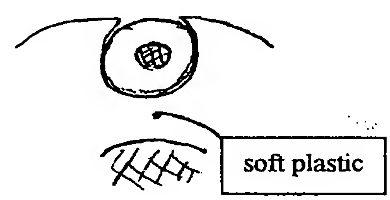
Groove geometry:



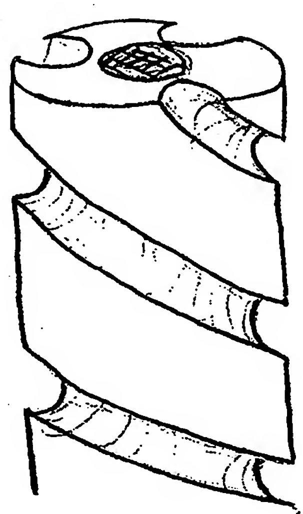
Groove filler material:



Soft plastic material:

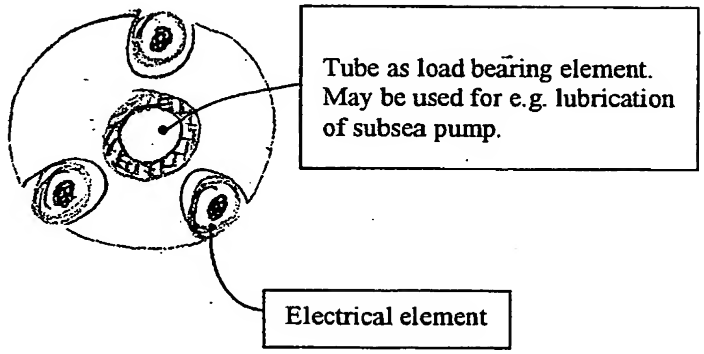


Side View:



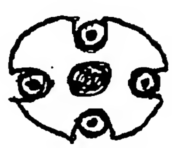
Secondary Features:

Multifunction element:

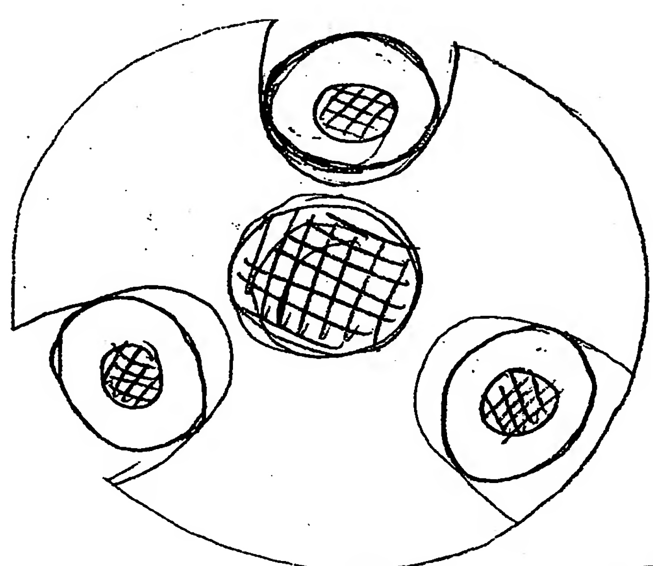


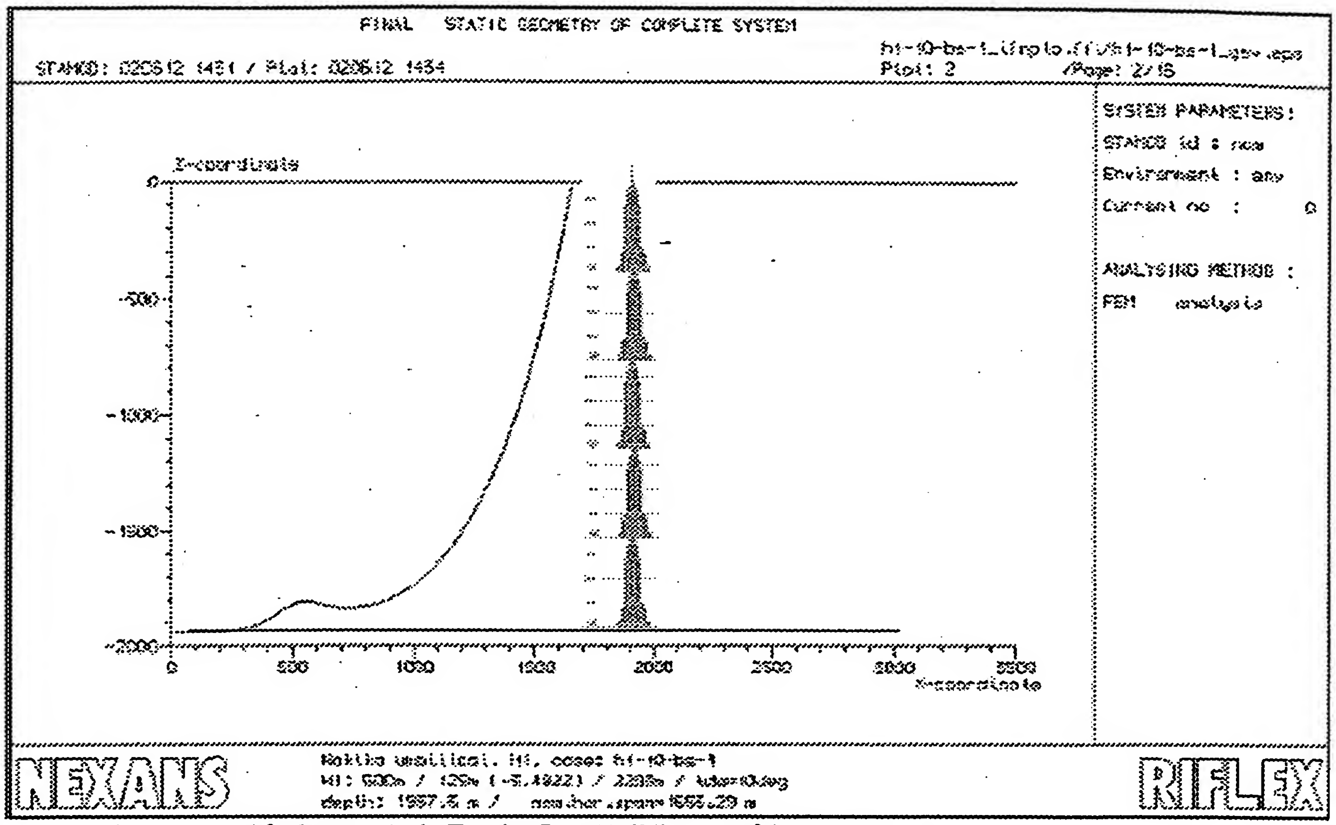
Scale feature:

Umbilical quad:

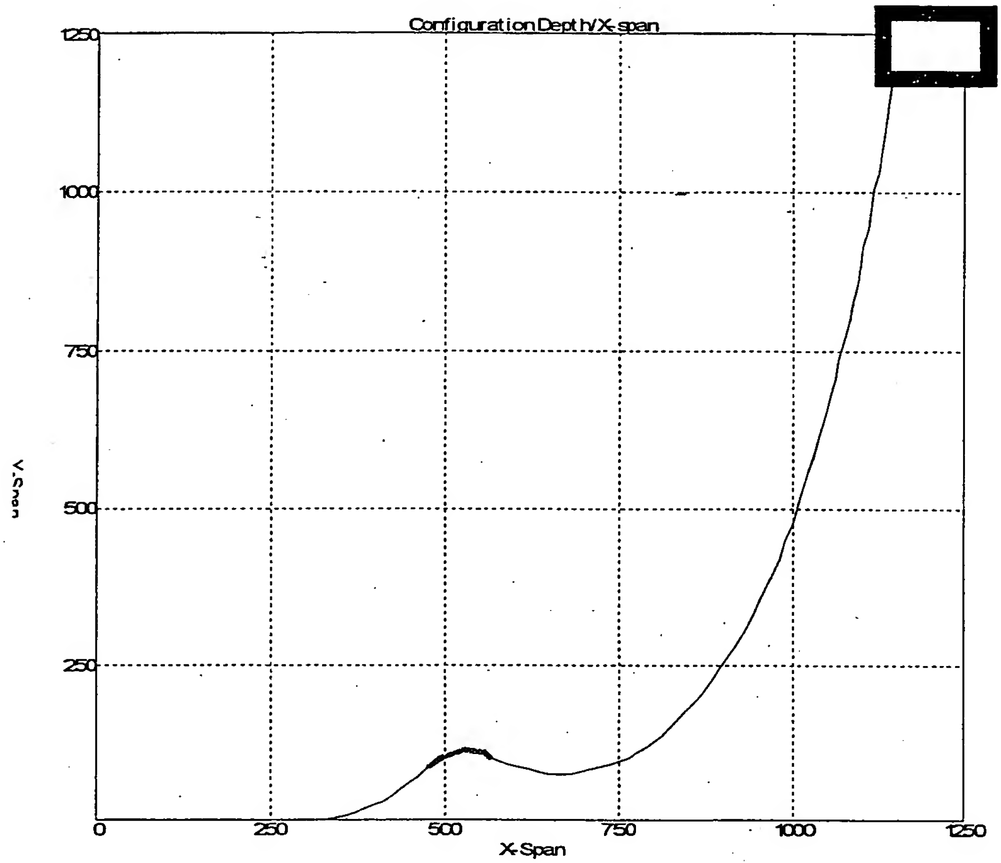


Power cable:





Vanndyp illustrert ved å plassere 5 stk. Empire State Buildings oppå hverandre.


Configuration Depth/X-span
1250
1000
750
500
250
0
250
500
750
1000
1250
X-Span
Y-Span

Invention Study No 128090

Vertical Cable Supporting Element

Patent claims (draft):

1. Device for supporting at least one elongated cable element () in a substantially vertical direction from a water surface vessel to a seabed installation,
characterized in that
the device is provided with at least one spirallized groove () for said cable element ().
2. Device according to claim 1,
characterized in that
the device includes a steel core () encompassed by a plastic/elastic layer () provided with said at least one groove ().
3. Device according to claim 1 or 2,
characterized in that
the plastic/elastic layer () consists of extruded crosslinked polyethylene (XLPE) or a thermoplastic polymer.
4. Device according to claim 2 or 3,
characterized in that
the steel core () consists of a metal tube () eg for transporting power and/orlubrication to the sea bed installation.
5.Device according to any one of the preceeding claims,
characterized in that
the helical angle of the grooves () are some 60 to 80 degrees.
6. Device according to any one of the preceeding claims,
characterized in that
the grooves () are adapted in size to the cable elements () so that cable element mass and inertia forces are continuously transferred to the plastic/elastic layer along the length of the element.
7. Device according to claim 6,
characterized in that
the grooves () are adapted in size to the cable elements () , such that the elements can slide radially or sideways in the groove
- but still be tight enough to transfer mass and inertia forces.

OH/220503